

Space Transportation Vehicle Division



STS-135 MOD FRR

June 14, 2011

DS/Jim Azbell

DS Shuttle CoFR Status Summary

REQUIREMENT	Training	DPS	INCO	MMACS	EGIL	EECOM	GNC	PROP	BOOSTER
Critical Processors/Applications	N/A	G	G	G	G	G	G	G	G
Non-Crit Processors/Applications	N/A	G	G	G	G	G	G	G	G
EMCC	N/A	G	G	G	G	G	G	G	N/A
Training - MCC/POCC	G	G	G	G	G	G	G	G	G
Training - Crew	G	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Training - SMS	G	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LCC/MEL/MIL	N/A	G	G	G	G	G	G	G	G
FTP - New Ops	N/A	G	G	G	G	G	G	G	G
Flight Anomaly Resolution	G	G	G	G	G	G	G	G	G
Anomaly – Procedures	N/A	G	G	G	G	G	G	G	G
Exceptions/Action Items from prior reviews	G	G	G	G	G	G	G	G	G
CIL/Hazards	G	G	G	G	G	G	G	G	G
No Constraints	G	G	G	G	G	G	G	G	G
Level II Actions	G	G	G	G	G	G	G	G	G
Mission Requirements	G	G	G	G	G	G	G	G	G
Engineering Drawings	N/A	G	G	G	G	G	G	G	G
Command Procedures	N/A	G	G	G	G	G	G	G	G
Flt Prep Process Plan Requirements Met	G	G	G	G	G	G	G	G	G
Contractor Process Insight	N/A	G	G	G	G	G	G	G	G
MOD Work Guidelines	N/A	G	G	G	G	G	G	G	G

SSP Electrical Summary

Reactants	Tanks	Liftoff Load	Min L/O	Margin	Padhold
		(lbm)	(lbm)	(lbm)	(hrs)
H2	5	455.5	430.8	24.7	73.8
O2	5	3886.4	3701.1	185.3	185.2

- NOTES:
- 1) Assumes 12+0+2 day mission with 1+1 ISS-based EVAs
 - 2) Assumes H2 target load obtained and loading completed at L- 45.0 hrs
 - 3) Assumes O2 target load obtained and loading completed at L- 47.5 hrs
 - 4) 2 KSC – 2 KSC – 2 EDW deorbit opportunities protected
 - 5) 14.0 lbm O2 protected for PMA/ODS Repress, MPLM Vestibule Repress, 1 scheduled, EVA, and 1 unscheduled EVA
 - 6) Payload Energy Summary: MPLM (55.6 kWh), Robotic Refueling (18.6 kWh), TRiDAR(11.5 kWh), and PSSC (11.0 kWh)
 - 7) Middeck Energy Summary: GLACIER (24.3 kWh), STL (10.1 kWh), CGBA 1&2 (47.4 kWh), and AEM 1,2,3 (36.6 kWh)
 - 8) An additional day could be added with an on time launch and an energy buyback of 85 kWh, equivalent to a 425 W powerdown for 200 hrs.
 - 9) CSCS capability allows for 16 days docked with 140 lbm O2 margin and unmanned undock on FD19. O2 margin includes metabolic for 6 ISS crew for the docked duration.

SSP Environmental Summary

Consumable	L/O Load	Min L/O	Margin
N2 (lb)	321.8^{1,2}	257.7³	64.0
Supply H2O (lb)	353⁴	353	0
LiOH (cans)	31⁵	25	6

- NOTES:
- 1) Assumes 12+0+2 day mission
 - 2) N2 L/O load protects/reflects KSC 6 lbm prelaunch usage requirement
 - 3) N2 loading protects for 1 scheduled ISS based EVA and 1 unscheduled ISS based EVA
 - 4) Supply H2O loading reflects a 180 lbm offload
 - 5) 25 LiOH canisters are required for a 12+0+3 day mission (4 Shuttle crew, 6 ISS crew for 8 docked days). 31 cans will be stowed/installed on the middeck. 6 cans will be transferred to the ISS Contingency Reserve. The equivalent of 29 canisters will be provided by ISS CDRA (dual bed) and Vozduhk to support Shuttle docked operations.

Status of Standard Open Work

Title	Actionee	Std / Non-Std	Mandatory / Non-Mand	ECD
Waste H2O Plan / WHC Use	EECOM	Std	Mand	ongoing
LiOH / Supply H2O / Pressure Plan	EECOM	Std	Mand	ongoing
Certification/Proficiency/Physical	Various	Std	Mand	6/30/11
Complete crew training	Various	Std	Mand	7/1/11*
Complete Integrated training	Various	Std	Mand	7/1/11*

*Assumes a 7/8/11 launch date

Status of Non-Standard Open Work

FLIGHT ANOMALY RESOLUTION - All previous in-flight anomalies have been resolved and all operational or procedural changes required have been implemented and verified. Exceptions are noted below:

STS-134 Post Landing Left Main Gear Fire – During landing of STS-134/Endeavour, there was visual evidence of a fire in the vicinity of the Left Inboard (LIB) tire. The fire started a few seconds prior to wheelstop (during braking) and lasted approximately 50 sec before extinguishing itself. Post landing inspections of the vehicle did not find any signs of fire. Overall brake energy was higher than normal this landing, due to higher braking on the left side, but similar to previous flights. KSC does not believe that the fire posed any hazard to the flight crew or ground crew. Root cause determination and additional inspections are still in work. The MMACS group is tracking this issue to determine potential impacts for STS-135.

Status of Non-Standard Open Work, cont.

CIL/HAZARDS - All procedures and flight rules which furnish and operational control for a Crit 1 or 1R Critical Items List item have been verified. Any new CIL items have been reviewed for possible operation control requirements and the appropriate procedure or flight rule implemented and verified. All such procedures or flight rules are flagged in the documents where they appear. The payload hazards have been reviewed and any flight rules or procedures required to provide operational control of the hazards, as identified by OCADs and all applicable Payload Safety Packages, have been implemented and verified. Required "Cautions" and "Warnings" have been incorporated. Exceptions are noted below:

Cabin Leak Procedure Deficiency - During the STS-135 emergency sim, a deficiency was discovered in the cabin leak procedure flow. After the crew has performed Joint Emergency Egress and Shuttle cabin leak isolation steps, all hatches between ISS and Shuttle are closed, including the Shuttle Inner Hatch. If there is a Shuttle cabin leak that requires the use of ISS atmosphere, the cabin leak procedure sends the crew to Joint Ops 9.103 Utilize ISS Atmosphere, which has the crew open equalization valves between the two vehicles. The first Shuttle crew step in that procedure is to open the ODS Hatch Equalization Valves, but this is not possible without first opening the Inner Hatch. There is no step in either procedure to open this hatch. The STS-135 crew and lead flight director are aware of the issue and there is a CR in the system to add the required step to the Utilize ISS Atmosphere procedure.

Info Only - Changes due to 4 person crew

- APCL
- Bailout procedures
- SYS AOA
- Post-Insertion
- Rendezvous
- OPCL
- Deorbit Prep
- Post Landing
- DTV wiring
- CSA-CP locations
- Middeck comm config
- EVA NH3 response
- ECLS FRP-3:
Fire/Haz Spill O2 Ctrl
- WHC/WCS Usage

Details in Backup

STS-134 Space Transportation Vehicle Division Readiness Statement

The Space Transportation Vehicle Division has performed the reviews necessary to assess the flight readiness relating to vehicle systems requirements definition, crew and flight controller training, and operations. We have determined all applicable responsibilities acceptable for flight pending closure of the identified open work and issues.

Original signed by

June 14, 2011

Gregory T. Oliver

Chief, Space Transportation Vehicle Division

As compiled by: DS/Jim Azbell

Backup

Standard Open Work Training-MCC, FCRs

Position	Name	Team	Open Item	ECD
Orbit EGIL	Michael Maher	O1	Cert Proficiency (expires 6/17/11)	6/17/11
Orbit EGIL	Kevin Jennings	O2	Cert Proficiency (expires 7/19/11)	6/24/11
MMACS	Eddie Eskola	O3	Cert Proficiency (expires 6/17/11)	6/11/11
GNC	Jason Helms	O4	Cert Proficiency (expires 7/8/11)	6/22/11
GNC	Kara Pohlkamp	O1 b/u	Cert Proficiency (expires 7/8/11)	6/22/11
A/E EGIL	Mark Welch	A/E	Physical (expires 6/30/11)	6/25/11
Orbit EGIL	Christi Worstell	O4	Physical (expires 7/31/11)	7/31/11
MMACS	Kevin McCluney	A/E	Physical (expires 7/31/11)	6/14/11 (Part 1)
INCO	Steve Sides	A/E	Physical (expires 6/30/11)	6/30/11

Standard Open Work Training-MCC, MPSRs

Position	Name	Team	Open Item	ECD
Support	Melissa Chavez	O2	Cert Proficiency (expires 7/4/11)	6/22/11
RF Comm	Eric Riecks	O1	Cert Proficiency (expires 7/26/11)	6/30/11
Mech	Laura Slovey	A/E	Cert Paperwork	6/11/11
Sensors	Kara Pohlkamp	A/E	Cert Paperwork	6/22/11
DPS SPT	Luis Ramirez	A/E	Physical (expires 7/31/11)	7/31/11
Thermal	Sarah McGregor	A / O4	Physical (expires 7/31/11)	TBD

Changes due to 4-person crew

- Nominal Timeline –
 - Wired the DTV differently so that prior to T-9 the PLT could activate DTV by turning on the AUX PL switch on panel R1. A 5th crewmember on the middeck would normally activate the DTV recorder from there. This also resulted in the addition of a prelaunch call to have the PLT do this step (during the T-9 hold prior to when we pick up the count at T-9 in regular ascent sims). Coordinated with EGIL, Photo/TV, and VITT office for the new OTC call.
 - Swapped the CSA-CP and some photo/TV equipment between the middeck and the flight deck in case of a smoke event so that the crew has the hardware handy. Coordinated with Photo/TV, Crew Systems, and EECOM.
- APCL – The Post-Fire Cabin Cleanup (p. 4-18) is written for 3 MS crew. One MS will do the CM1 actions (powerdown) and one will do CM2 and CM3 (CSA-CP and purge). [Note: on-orbit procedure written for 2 MS to perform, while ascent version is for 3 MS]
- Deorbit Prep – Crew will do some middeck stuff early, like airlock closeout and Galley/WCS. Coordinated with EECOM.

Changes due to 4-person crew

- Bailout procedures were slightly modified because there's nobody on the middeck to vent the cabin prior to hatch jettison (which would now be done by the MS climbing down from the flight deck).
- Post-Insertion –
 - Crew will probably get to the WCS and Galley actions later than a normal crew. Coordinated with EECOM.
 - In sim, crew didn't complete block 15 Airlock Prep until 4:40 MET because they are going to wait until everything else on the middeck is complete (in particular, PGSC setup). Normally done at 2:00 MET per checklist.
 - Some actions will be single crewmember without a backup. For example, around 1:00 MET the PLT and CDR are doing block 1 to reconfigure the GPCs, one MS is doing middeck config, and one MS is doing aft station config. No impact to timeline, just will only have one set of eyes instead of two.
- Post Landing - GNC has been notified that due to reach restrictions and the MS2 and MS1 leaving the shuttle quicker than normal due to nobody on the mid deck in front of them to be removed, the GPS Powerdown actions for panel A13 in Post Landing will not be completed by the crew but will be left for the ASP to complete.

Changes due to 4-person crew

- SYS AOA –
 - While performing standalone training on Loss of 2 Freon Loops SYS AOA, the crew reported they could not perform the middeck steps because they plan to stay strapped in. The Loss of 2 Freon loop procedure flow has the crew take MCA Logic switches in the middeck to OFF, and then back to ON for Vent Doors at EI-7. Leaving these switches ON for the duration of the SYS AOA will not cause a significant impact to the Orbiter's overall heat load.
 - GNC has been notified that on pg 3-2 of the SYS AOA book there is a callout to do a Torque align in the procedure. The crew feels they do not have enough time to come back and finish up the steps 6 min later when the torque align would complete, so they have chosen to do a Matrix align in this scenario and press on.
 - Placeholder- Pending outcome of AEFTP – PL PWRDOWNS – both Loss of 2 Freon Loops and Loss of 2 H2O Loops call for powerdown of all Middeck Payloads (STL, AEM I, II, & III, and CGBA 01 & 02 ~300 watts total). DS, lead by EECOM (M. Fitzpatrick), was asked to look at not powering down Middeck payloads for SYS AOA procedures. Crew would have difficulty performing due to being strapped in on the FD. The additional heat load in the crew module will be tolerable since it is less than the heat load generated by 3 additional crew. Additional power at the Fuel Cell may not be acceptable for the Loss of 2 Freon Loop case with total loss of cooling.

Changes due to 4-person crew

- AOA size Cabin Leaks - If an AOA is required due to a cabin leak on ascent, particularly if a Loss of Cabin Press Powerdown was required (landing below 10.2 psi), the crew will be very busy in both the Flight Deck and Middeck. The nominal procedural flow has the CDR/PLT working the standard AOA procedures with Loss of Cabin Press deltas. One Mission Specialist will need to access the Middeck to work leak isolation troubleshooting and potential sealing. The other Mission Specialist will be on the Flight Deck working the Loss of Cabin Press powerdown, as required, which includes a Payload Powerdown in the Middeck.
- Middeck ATU Configuration for Ascent - The MD ATU will be set up in the post insertion configuration for ascent, including the speaker switch in the on position. This off nominal configuration is being utilized to optimize crew time in post insertion while also preserving limited comm capability in a bailout scenario. The MD ATU circuit breaker will be out for ascent, and only pushed in during powered flight if a bailout scenario is called. When the breaker is pushed in the MD speaker unit is then powered, allowing listen capability for MS2 while he performs bailout actions in the middeck. In a nominal ascent case, the circuit breaker will be pushed in during post insertion to allow for quick setup of middeck comm with very little crew action required.

Changes due to 4-person crew

- Rendezvous –
 - Block D of the Approach Cue Card is placed after the RPM where MS3 could do the actions, but with only 2 MS, Sandy and Rex are busy with HHL and photography. These actions (hatch closeout and Docking Mech Powerup) will be moved earlier to take place during the RPM instead. Coordinated with EECOM and MMACS.
 - Due to a reduced crew size and timeline constraints on flight day 3, the crew plans to perform Airlock Fan Act and ODS Volume Prep earlier than it is scheduled in the rendezvous timeline. On STS-110, the crew closed out the airlock early (prior to Ti) and condensation formed on the ODS hatch window. Consequently, recent analysis was performed to analyze early hatch closure. The analysis showed that condensation is unlikely to form and should resolve when the ducting is configured for docking. The STS-110 case is unexplained. The crew plans to perform this procedure during the RPM.

Changes due to 4-person crew

- Loss of 2 Water Loops Contingency Deorbit
 - The powerdown (OPCL) has MS3 perform Comm powerdown while MS1 and MS2 do overhead, aft, and middeck powerdowns. The crew's pre-sim tagup addressed this and they will do some of the powerdowns sequentially instead of simo.
- Av bay fire Contingency Deorbit
 - Nothing significant
- Cabin leak → JEUS
 - The procedures assume at least one MS will do undocking, and three MS are called out in the cabin leak procedure (OPCL p. 4-5), with at least one more implied for middeck stowage activities. The crew prebriefed this and will have a single MS working undocking while the other does the leak isolation and cabin stow. They executed this plan in the sim with no problems.

Changes due to 4-person crew

- The four person crew will result in ISS crew members performing the mission's EVA. In the event of an ISS ammonia leak during the EVA, it has been decided that the EVA crewmen will ingress through the shuttle airlock. As they are ISS crew members, there will be no seats or ACES suits available for them if they come home on shuttle. Without an ACES suit, a successful bailout will not be possible. The Program Office has decided to accept this risk for STS-135. It is possible for EMU-suited crew members to ingress ISS through the Russian airlock (DC1), but only if an Orlan-suited crew member is available to open the hatch from the inside.

Changes due to 4-person crew

- **ECLS FRP-3: FIRE/HAZ SPILL O2 CONTROL** - This malfunction procedure contains multiple tables that are dependent on crew size and are only populated with values for 5-8 crew. Working this procedure using the values for 5 crew is conservative for a 4 person crew, and does not present additional risk. The crew has been trained to use the tables in this procedure for 5 crew, but understands that MCC may provide different values if comm is available.
- **Loss of 2 Freon Loops/Water Loops on Orbit** - The procedures for Loss of 2 Freon Loops and Loss of 2 Water Loops on orbit contain steps to be worked in parallel by five separate crew members, with specific MS1, MS2, and MS3 actions. The STS-135 crew has been trained on this issue, and the two Mission Specialists understand that they will prioritize all MS actions appropriately, performing some actions sequentially which are called in the procedure to be worked in parallel.
- **WCS/WHC Usage** - With only 4 Shuttle crew, there is enough ullage in the waste tank to make it through the docked duration without a waste water dump. The Shuttle crew will still be asked to use the WHC as much as convenient to provide more waste water for processing on ISS.

Additional Changes

- **Deletion of Radiator Retract Hose Viewing in D/O Prep** – Radiator Retract Hose viewing during Deorbit Prep is not required because it will not affect ground turnaround for future flights. This decision was approved by the ATCS PRT and the crew requested that Deorbit Prep deltas be uplinked as part of the entry messages.
- **EMU Checkout** – EMU checkout of the Shuttle EMUs will be performed on ISS during the docked duration instead of on the Shuttle on FD2. This procedure will use Shuttle O2 flowing through ROOBA to check out the EMUs, but this is no impact to EECOM.

Leaking CWC-Is and PWRs

- Recently, there have been multiple leaking CWC-Is and PWRs on ISS. During STS-134, ISS requested transfer of Shuttle 36x36” Ziplock bags to use for containment of these leaking CWC-Is and PWRs. On each Shuttle flight, 10 Ziplocks are manifested, and 6 of these were transferred to ISS during STS-134. All 6 were used during the mission to contain leaking CWC-Is and PWRs. The leaking CWC-Is will either be trashed in ATV or returned on STS-135 in the MPLM. The following are the leaking bags on ISS:
 - CWC-I 2067 (~18 lb) - Leaking, stinky, and molding. Currently in JEM. No plans to reclaim or vent the water.
 - CWC-I 2047 (~41 lb) - Large leak. Currently in ATV. No plans to reclaim or vent the water.
 - CWC-I 2034 (~45 lb) - Large leak. Currently in ATV. No plans to reclaim or vent the water.
 - CWC-I 1022 (~43 lb) - Leaking. Currently in PMM. No plans to reclaim or vent the water.
 - PWR 1007 (~18 lb) - Filled and reported to have a small leak on STS-134. Currently in ISS A/L and will likely return on STS-135 in the MPLM.

STS-133 External Tank Intertank Stringer Cracks

- As part of the ongoing activities associated with the ET Intertank stringer cracks, the STS-135 ET (ET-138) received the radius block modifications to increase structural margin. A tanking test will be performed on 6/15, and will be supported at JSC with a limited team including Booster, Flight, and GC. After the test is complete, x-rays inspections will occur on the LO2 and LH2 intertank panels that are accessible from the pad structure. There is no open work for Booster regarding this issue, other than the on-console support during the tanking test.

APU Dual Fuel Line Heater Failure

- During STS-134 prelaunch, APU 1B fuel service line and test line heaters were determined to be nonfunctional, and launch was scrubbed due to the LCC violation. A conclusive cause for the failure was never determined, so the failure remained an Unexplained Anomaly. The MMACS group was asked to evaluate options for responding to a dual fuel feedline, test line, and/or service line heater failure. Current flight rules call for an orbiter attitude adjustment in order to keep the fuel lines above the freezing temperature of 35 deg F. For STS-134, MER TCS determined that it would not be possible to keep the fuel lines above freezing temperatures for the duration of the docked mission, so a change in operational philosophy was warranted. An APU fuel line that undergoes more than one freeze/thaw cycle could result in line rupture and hydrazine leakage into the aft compartment, which is a potentially catastrophic hazard. After discussions with the APU engineering community, Orbiter Project, and DA8, the decision was made to operate the affected APU to depletion if prior to docking or post-undocking, or to allow the APU fuel lines to freeze and remain frozen during the docked mission. Existing flight rules do not account for operating the APU to depletion or allowing the fuel lines to freeze for the dual heater failure case, so revisions to *A10-30 Loss of APU Heaters/Instrumentation* and *A10-31 APU Freeze/Thaw* were submitted for the STS-135 annex book. Similar rules were approved out of board for STS-134.

Modifications to Docking Sequence Cue Card

- During STS-133, large misalignments were seen during docking such that the docking mechanism reached the hardstops and hard mate took well over 30 minutes. The docking signature was very similar to STS-130. The docking community has since brought up several concerns with respect to the time it takes to get docked, such as ISS longeron shadowing, Shuttle to Station vehicle clearance, ISS power, ISS passive thermal constraints, and timeline impacts. To mitigate these concerns, the MMACS group worked with the ODS IPT and Energia on changes to the Docking Sequence Cue Card for STS-134 and STS-135. The current procedure does not use the fixers to maintain alignment because previously, the engineering community did not have the data to prove that it was safe. After further discussions post STS-130 and STS-133 dockings, the engineering community now believes that relying on the fixers to maintain alignment is acceptable, and was the intent of the original design, but they are gathering the data to validate that point. At the 4/6/11 JOP, MMACS recommended changing the cue card to rely on the fixers, and to only pause ring retraction if the fixers are determined to not be properly engaged. The GJOP approved the recommendation, and the change flew for the first time on STS-134, with no issues. Revisions to *A10-343 APDS Mechanism End of Travel Indications* and *A10-344 APDS Docking Sequence Operations* were submitted for the STS-135 annex book to reflect the new operational philosophy.

STS-134 SSP Electrical Summary

Reactants	Tanks	Liftoff Load	Min L/O	Margin	Padhold
		(lbm)	(lbm)	(lbm)	(hrs)
H2	5	455.5	375.6	79.9	217.2
O2	5	3495.0	3397.6	97.4	87.8*

- NOTES:
- 1) Assumes 14+1+2 day mission with 4+1 ISS-based EVAs
 - 2) Assumes H2 target load obtained and loading completed at L- 45 hrs
 - 3) Assumes O2 target load obtained and loading completed at L- 41 hrs
 - 4) 390* lbm O2 offloaded evenly from Tanks 1, 2, 3, 4, and 5
 - 5) 54 lbm O2 protected for 4 scheduled EVAs, 1 unscheduled EVA, PMA/ODS repress, and 30 lbm ISS O2 transfer
 - 6) SSPTS output energy provided is 1717.0 kWh based on:
 - 4 OPCU converters for 214.70 hrs (including Additional Day)
 - 2 OPCU converters for 21.75 hrs (EVAs 1, 3 & 4, and Water Dump)
 - 1 OPCU converter for 3.75 hrs (portions of EVAs 1 and 4)
 - SSPTS deactivated 8 hrs for EVA 2
 - 7) 2 KSC - 2 KSC - 2 EDW deorbit opportunities protected
 - 8) CSCS capability with 4 SSPTS converters allows for 25 days docked with 4 lbm O2 margin and unmanned undock on FD28. O2 margin includes metabolic for 6 ISS crew for the docked duration.

* CR approved 2/25/11 decreases offload to 375 lbm O2 resulting in 101.8 hrs Padhold

STS-134 SSP Environmental Summary

Consumable	L/O Load	Min L/O	Margin
N2 (lb)	321.8^{1,2}	315.8	6.0
Supply H2O (lb)	353⁴	353	0
LiOH (cans)	31⁵	31	0

- NOTES:
- 1) Assumes 14+1+2 day mission
 - 2) N2 L/O load protects/reflects KSC 6 lbm prelaunch usage requirement
 - 3) N2 loading protects for 4 scheduled ISS based EVAs and 1 unscheduled ISS based EVA
 - 4) Supply H2O loading reflects a 180 lbm offload
 - 5) 87 LiOH canisters are required for a 14+1+3 day mission.

The equivalent of 56 canisters will be provided from ISS resources. 9 pre-positioned canisters will be taken from the LiOH stockpile, and the equivalent of 47 canisters will be provided by ISS CDRA (dual bed) and Vozdukh to support Shuttle docked operations.